इंटरनेट मानक

Disclosure to Promote the Right To Information

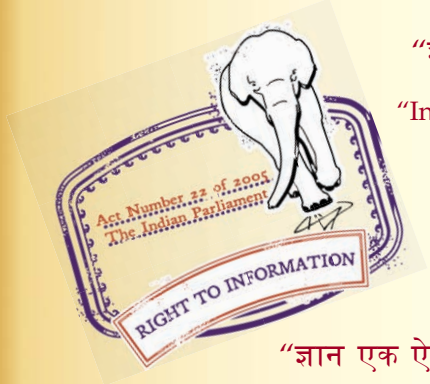
Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 3700-7 (1970): Essential Ratings and Characteristics of Semiconductor Devices, Part VII: Reverse Blocking Triode Thyristors [LITD 5: Semiconductor and Other Electronic Components and Devices]

"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"



"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

BLANK PAGE

PROTECTED BY COPYRIGHT

IS : 3700 (Part VII) - 1970
(Reaffirmed 2006)

Indian Standard

ESSENTIAL RATINGS AND CHARACTERISTICS OF SEMICONDUCTOR DEVICES

PART VII REVERSE BLOCKING TRIODE THYRISTORS

(Second Reprint MARCH 1991)

UDC 621.382.012

© *Copyright* 1970

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 4 *August* 1970

Indian Standard

ESSENTIAL RATINGS AND CHARACTERISTICS OF SEMICONDUCTOR DEVICES

PART VII REVERSE BLOCKING TRIODE THYRISTORS

Semiconductor Devices Sectional Committee, ETDC 40

Chairman	*Representing*
DR B. H. WADIA	Semiconductors Limited, Poona
Members	
DR K. S. BALAIN	Central Electronics Engineering Research Institute (CSIR), Pilani
DR B. R. MARATHE (*Alternate*)	
DR R. R. DUTTA GUPTA	Directorate General of Inspection (Ministry of Defence)
SHRI R. S. YADAV (*Alternate*)	
SHRI S. K. GANGULY	Directorate General of Civil Aviation
SHRI B. P. GHOSH	National Test House, Calcutta
SHRI A. K. GOPALAKRISHNAN	The Radio, Electronics & Television Manufacturers' Association (RETMA), Bombay
WG CDR J. S. LAMBA	Directorate of Technical Development & Production (Air) (Ministry of Defence)
SHRI E. G. NAGARAJAN (*Alternate*)	
SHRI S. S. MADAN	Continental Device India Ltd, Faridabad
SHRI A. A. PATANKAR (*Alternate*)	
SHRI G. B. MEEMAMSI	Directorate General of Posts & Telegraphs (Department of Communications), New Delhi
SHRI B. S. MURTHY	Directorate General of Defence Research & Development (Ministry of Defence)
SHRI K. C. CHHABRA (*Alternate*)	
SHRI P. S. RAJU	Electronic Corporation of India Ltd (Department of Atomic Energy), Hyderabad
DR RAM PARSHAD	National Physical Laboratory (CSIR), New Delhi
SHRI S. P. SURI (*Alternate*)	
SHRI K. R. SAVOOR	Bharat Electronics Ltd, Bangalore
SHRI C. G. SUBRAMANYAN	Directorate General of Defence Research & Development (Ministry of Defence)
SHRI Y. S. VENKATESWARAN, Director (Elec tech)	Director General, ISI (*Ex-officio Member*)

Secretary

SHRI N. SRINIVASAN

Deputy Director (Elec tech), ISI

(*Continued on page* 2)

BUREAU OF INDIAN STANDARDS

MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG

NEW DELHI 110002

(*Continued from page* 1)

Panel for Thyristors, ETDC 40/P2

Convener	*Representing*
SHRI B. S. MURTHY	Directorate General of Defence Research & Development (Ministry of Defence)
Members	
SHRI S. M. KHER	Hind Rectifiers Ltd, Bombay
SHRI S. M. MANE (*Alternate*)	
SHRI G. B. MEEMAMSI	Directorate General of Posts & Telegraphs (Department of Communications), New Delhi
SHRI I. M. RAO	RI-Semikron Pvt Ltd, Bombay
SHRI S. N. SESHADRI	Bhabha Atomic Research Centre, Bombay
SHRI V. N. SOMAN	Semiconductors Ltd, Poona

Indian Standard

ESSENTIAL RATINGS AND CHARACTERISTICS OF SEMICONDUCTOR DEVICES

PART VII REVERSE BLOCKING TRIODE THYRISTORS

0. FOREWORD

0.1 This Indian Standard (Part VII) was adopted by the Indian Standards Institution on 21 January 1970, after the draft finalized by the Semiconductor Devices Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard deals with the essential ratings and characteristics and other information to be specified for reverse blocking triode thyristors (semiconductor controlled rectifier) which may be of the '*P* Gate' or '*N* Gate' types. The term reverse blocking triode thyristors has been abbreviated to 'Thyristor' in this standard. 'Turn-off Thyristors', that is, thyristors turned off by gate control, are not covered by this standard.

0.2.1 This standard is to be used in conjunction with IS : 3700 (Part I)-1966*.

0.2.2 Essential ratings and characteristics of rectifier diodes are covered by IS : 3700 (Part III)-1967†.

0.2.3 While the lists of ratings and characteristics have been kept at their minimum, a manufacturer may always give additional information at his discretion.

0.3 The object of this standard is to specify clearly the properties of the device for the intended application and to facilitate comparison and choice between similar products. It is anticipated that the adoption of this standard will ensure uniformity in the presentation of device data as well as certain minimum information on these essential ratings, characteristics and other parameters.

0.4 While preparing this standard, assistance has been derived from IEC Pub 147-1B Essential ratings and characteristics of semiconductor devices and general principles of measuring methods, Part 1B Rectifier diodes and thyristors, issued by International Electrotechnical Commission.

0.5 This standard is one of a series of Indian Standards on semiconductor devices.

---

*Essential ratings and characteristics of semiconductor devices: Part I General.

†Essential ratings and characteristics of semiconductor devices: Part III Rectifier diodes.

1. SCOPE

1.1 This standard (Part VII) covers essential ratings and characteristics and other information to be specified in the case of reverse blocking triode thyristors (abbreviated to thyristors) (otherwise known as 'Semiconductor controlled rectifiers'), which may be of the '*P* Gate or *N* Gate' types.

1.1.1 *Turn-off thyristors* (that is, thyristors turned off by gate control) are not covered by this standard.

2. TERMINOLOGY, GRAPHICAL SYMBOLS AND LETTER SYMBOLS

2.1 Terminology — For the purpose of this standard, the following definitions shall apply in addition to those specified in IS : 1885 (Part VII/ Section 4)-1969*.

2.1.1 *Surge Current* — A current which exceeds the rated mean current and is such that other electrical or thermal ratings of the device are exceeded.

NOTE — A surge current is assumed to occur only rarely with a limited number of occurrences during the service life of the device and to be a consequence of unusual circuit conditions, for example, an accidental short circuit.

2.1.2 *Overload Current* — A current of essentially the same waveshape and exceeding in magnitude the rated mean current such that no other electrical or thermal rating of the device is exceeded.

NOTE 1 — It is assumed that the overload current is applied after a previous period of operation at a current lower than the rated mean current.

NOTE 2 — An overload current may be applied frequently during the service life of the devices.

2.1.3 *Latching Current* — The minimum principle current required to maintain the thyristor in the on-state immediately after switching from the off-state to the on-state and the triggering has been removed.

2.1.4 *Reverse Recovery Current* — The transient component of reverse current of a thyristor associated with a change from forward conduction to reverse blocking.

2.2 Letter Symbols — For the purpose of this standard, the letter symbols given in IS : 3715-1966† shall apply.

2.3 Graphical Symbols — For the purpose of this standard, the graphical symbols specified in IS : 2032 (Part VIII)-1965‡ shall apply.

*Electrotechnical vocabulary: Part VII Semiconductor devices; Section 4 Thyristors.

†Letter symbols for semiconductor devices.

‡Graphical symbols used in electrotechnology: Part VIII Semiconductor devices.

3. ASSIGNED TYPE NUMBER

3.1 A type number shall be assigned for identification of the devices. The number shall be prominently displayed on the device. The assigned number shall be specified in accordance with IS : 4411-1967*.

4. CATEGORY AND DEVICE DESCRIPTION

4.1 The following as specified in **6.1** (b) of IS : 3700 (Part I)-1966† shall be furnished:

a) Material of the active part of the device,

b) Constructional details of the active part of the region and encapsulation, and

c) Intended major application or applications.

5. OUTLINES AND CONNECTIONS

5.1 An outline drawing, with base drawings showing essential dimensions and tolerances, location of terminals and other information shall be given (*see also* IS : 5000‡ series).

5.2 An accepted method of identification of the cathode or anode terminals or both shall be stated [*see also* **6.1** (c) of IS : 3700 (Part I)-1966†].

5.3 The terminal which is connected electrically to parts of the enclosure shall be stated.

5.4 A specific statement regarding the mode of cooling shall be made as per **4.2** of IS : 3700 (Part I)-1966†.

6. RATINGS (LIMITING VALUES)

6.1 General

6.1.1 Thyristors shall be specified as natural cooled (ambient rated), forced circulation cooled, or conduction cooled (case rated) devices. [*see* **4.2.1** of IS : 3700 (Part I)-1966†].

6.1.2 The values of voltage and current ratings shall be chosen from the preferred values specified in **5.1** of IS : 3700 (Part I)-1966†.

6.2 Rating Conditions — The ratings other than temperature ratings shall be stated according to the cooling conditions specified in (a) to (c):

a) *Natural Cooled* (*Ambient Rated*) *Thyristors* — At a reference point

*Code of designation for semiconductor devices.

†Essential ratings and characteristics of semiconductor devices: Part I General.

‡Dimensions of semiconductor devices.

temperature chosen from the list of preferred temperatures given in **4.2.2** of IS : 3700 (Part I)-1966*.

b) *Forced Circulation Cooled Thyristors* — Under specified conditions of preferred temperatures as given in **4.2.1** (b) of IS : 3700 (Part I)-1966* with the reference point temperature from the list of chosen preferred temperatures specified in **4.2.2** of IS : 3700 (Part I)-1966*.

c) *Conduction Cooled (Case Rated) Thyristors* — At a reference point temperature chosen from the list of preferred temperatures specified in **4.2.2** of IS : 3700 (Part I)-1966*. For silicon devices a temperature of 100°C is recommended.

6.3 Voltage Ratings — The voltage ratings as given in **6.3.1** and **6.3.2** under conditions specified against each shall be stated.

6.3.1 *Anode Cathode Voltages* — The following ratings shall be specified under gate open conditions:

a) Repetitive peak reverse voltage as a maximum value.

NOTE — Any qualification (for example, of time, energy, etc) applicable may be stated.

b) Non-repetitive peak reverse voltage as a maximum value [*see* Note under (a)]

c) Continuous (direct) reverse voltage as a maximum value, wherever appropriate.

d) Repetitive peak off-state voltage as a maximum value.

NOTE — The repetitive peak off-state voltage may also be specified under specified control signal and gate circuit impedance, where appropriate.

e) Non-repetitive peak off-state voltage as a maximum value.

NOTE — The non-repetitive peak off-state voltage may also be specified under specified control signal and gate circuit impedance, where appropriate.

6.3.2 *Gate Voltages* — The following gate voltage ratings shall be stated:

a) Peak forward gate voltage with anode positive with respect to cathode, as a maximum value;

b) Peak forward gate voltage with anode negative with respect to cathode, as a maximum value; and

c) Peak reverse gate voltage as a maximum value.

6.4 Principal Current (Anode Current) Ratings — The following principal current ratings under conditions specified against each shall be stated (and where applicable, separate ac and dc ratings should be given):

a) *Rated Mean On-State Current* — For single phase sinusoidal half wave circuit with 180° conduction angle and with resistive load,

*Essential ratings and characteristics of semiconductor devices: Part I General.

as a maximum value. In addition, conversion factors for other circuits should be given.

NOTE — The maximum rating given on the assumption that no overload occurs.

b) *Repetitive Peak On-State Current* — Where appropriate as a maximum value, this rating shall be expressed with relation to the forward conduction angle.

c) *Continuous (Direct) On-State Current* — as a maximum value.

d) *Overload On-State Current* — Where appropriate, this rating should be given by stating the maximum virtual junction temperature and the maximum transient thermal impedance. In addition overload current ratings may be given by means of diagrams (*see also* Fig. 1).

e) *Surge On-State Current* — Surge current ratings shall be specified for two different time periods at the initial conditions corresponding to the maximum virtual junction temperature as follows:

1) For times smaller than one half cycle (at 50 Hz) but greater than approximately 1 ms, in terms of maximum rated values of

$$\int i^2 dt$$

where i is the instantaneous value of off-state current. They may be given by means of a curve or by specified values. No immediate subsequent application of reverse voltage or off-state voltage is assumed.

2) For times equal to or greater than one half cycle (at 50 hz) and less than 15 cycles, in the form of a curve showing the maximum rated surge current versus time.

NOTE 1 — Temporary loss of gate control shall be assumed to occur.

NOTE 2 — These ratings should preferably be given for a reverse voltage of 80 percent of the maximum repetitive peak reverse voltage. Additional ratings may be given for reverse voltages of 50 percent of the maximum repetitive peak reverse voltage.

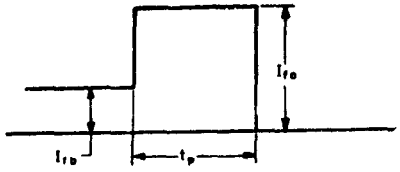
NOTE 3 — Additionally, a rating shall be given for a time equal to one cycle with no reverse voltage applied.

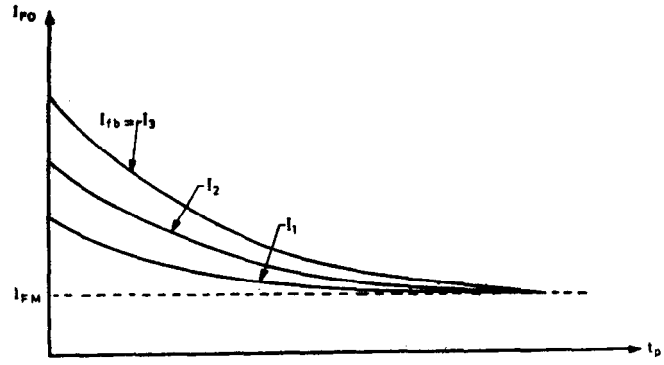
f) *Peak Reverse Recovery Current* — Maximum value at a specified value of on-state current and specified values of decay rate of the on-state current, reverse voltage and virtual junction temperature.

g) *Critical Rate of Rise of On-State Current* — As a minimum value (*see* Appendix A for details) (where appropriate).

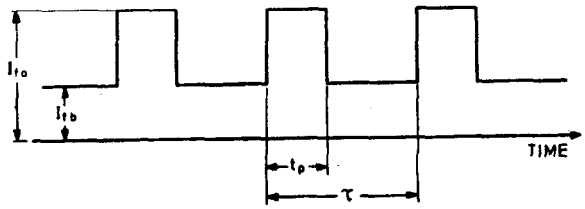
6.5 Gate Current Ratings

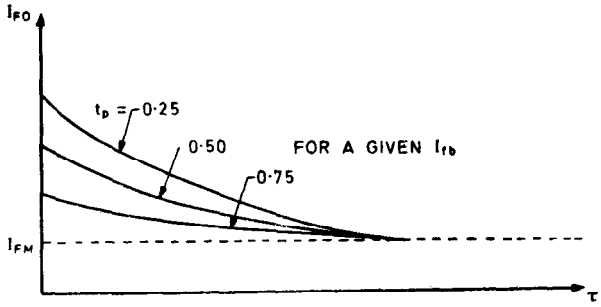
6.5.1 *Peak Forward Gate Current* — Peak forward gate current with anode to cathode voltage polarity specified shall be stated as a maximum value.





1A Single Overload





1B Multiple Overload

I_{fb} = basic load current
I_{fo} = overload current
I_{FM} = rated mean current
I_{FO} = rated overload current
I_1, I_2, I_3 = different values of basic load current
$I_{FM} < I_1 < I_2 < I_3$

FIG. 1 OVERLOAD

6.6 Reverse Recovery Charge — At a specified value of on-state current and specified values of decay rate of the previous on-state current, reverse voltage and virtual junction temperature, the reverse recovery charge shall be stated as a maximum value.

6.7 Frequency Ratings — Where appropriate, the maximum or minimum frequency or both for which the voltage and current ratings specified in **6.3** and **6.4** are applicable, shall be stated.

6.8 Power Dissipation Ratings

6.8.1 *Total Power Dissipation* — Curves showing maximum permissible power dissipation versus reference point temperature (with particular cooling conditions specified) shall be provided.

NOTE — As these ratings are temperature and frequency dependant derating, information should also be given.

6.8.2 *Gate Power Dissipation* — The following gate power dissipation ratings shall be specified:

a) Mean gate power as a maximum value, and

b) Peak gate power as a maximum value.

NOTE — As these ratings are temperature dependant, derating information should also be given.

6.9 Temperature Ratings — The following temperature ratings shall be stated:

a) Maximum and minimum reference point temperatures for which the voltage ratings specified in **6.3** are applicable, in the case of natural cooled and forced circulation cooled devices.

b) Maximum reference point temperature for which the current ratings specified in **6.4** and **6.5** are applicable, in the case of conduction cooled (case rated) devices.

c) Maximum and minimum storage temperatures.

d) Maximum and minimum virtual junction temperatures.

7. ELECTRICAL CHARACTERISTICS

7.1 General — The characteristics specified shall be measured at a reference point temperature of 25°C and when so stated at one other higher temperature specified in **6.2**.

7.2 Forward Characteristics — Where appropriate, curves showing instantaneous values of on-state voltage versus on-state current up to the maximum value of the repetitive peak on-state current [*see* **6.4** (b)] at a reference point temperature of 25°C and at one other higher temperature of reference point chosen in **7.1** shall be provided.

7.3 On-State Voltage — The on-state voltage shall be expressed as a maximum value at the maximum continuous (direct) on-state current [*see* **6.4** (c)] or at any other specified value of continuous (direct) on-state current.

7.4 Latching Current — The latching current shall be expressed under specified conditions of load gate impedances as a maximum value.

7.5 Holding Current — The holding current shall be quoted as a maximum and minimum value under specified conditions of load and gate impedances.

NOTE — The maximum value of the holding current is the smallest current which will maintain all thyristors in the on-state. The minimum value of the holding current is the highest current below which all thyristors will return to the off-state.

7.6 Instantaneous Off-State Current — The instantaneous off-state current shall be expressed in terms of the following:

a) Maximum value at the repetitive peak off-state voltage [*see* **6.3.1** (d)] under specified conditions at a reference point temperature of 25°C and at the maximum virtual junction temperature, and

b) A second maximum value at the other higher reference point temperature specified in **7.1** and at the maximum virtual junction temperature.

7.7 Reverse Current — The reverse current shall be expressed in terms of the following:

a) Maximum value at the maximum value of the repetitive reverse voltage [*see* **6.3** (b)] under specified conditions at a reference point temperature of 25°C, and

b) A second maximum value at the other higher reference point temperature specified in **7.1**.

7.7.1 *Instantaneous Reverse Current* — The maximum value at the rated repetitive peak reverse voltage at 25°C and at the maximum virtual junction temperature.

7.8 Gate Trigger Current and Gate Trigger Voltage — The values of gate current and gate voltage required to turn-on all thyristors under specified conditions. Any other conditions affecting the values of these characteristics should also be specified.

NOTE — Usually a low anode-cathode voltage (say 6V) is applied in the forward direction.

7.8.1 *Gate Characteristic Curve* — Limiting values and characteristics relating to the gate should be preferably given with reference to a diagram as shown in Fig. 2. The area indicating possible triggering may have an upper limit given by two lines defined by the maximum gate trigger

current and voltage, or a single line indicating a suitable output characteristic of a trigger equipment.

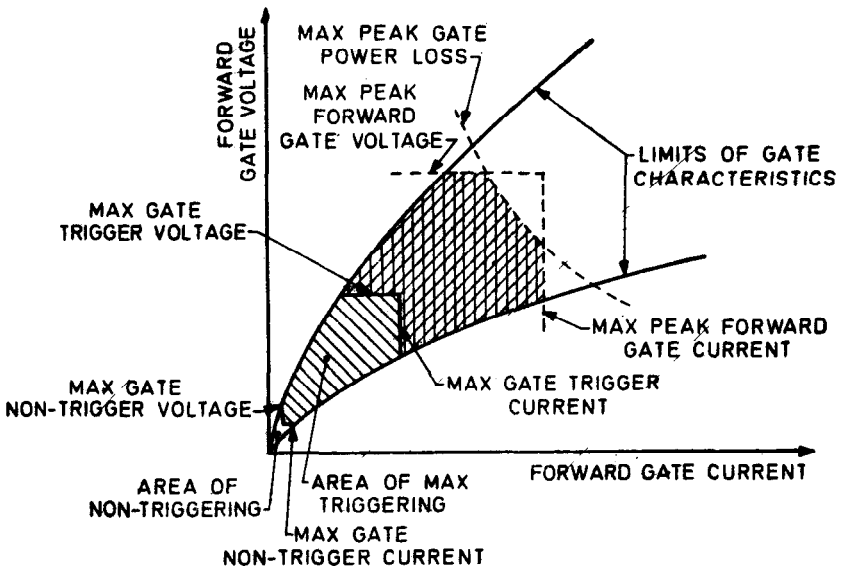


FIG. 2 GATE CHARACTERISTICS

7.9 Gate Non-trigger Current and Gate Non-trigger Voltage — The values of gate current and gate voltage which will not turn-on *any thyristor* at the maximum peak off-state voltage shall be specified. Any other conditions affecting the values of these characteristics should also be specified (*see also* **7.8.1**).

7.10 Gate Controlled Turn-On Time — The gate controlled turn-on time shall be specified as a typical value and where appropriate as a maximum value, under specified conditions.

7.11 Circuit Commutated Turn-Off Time Circuit Commutated Recovery Time — The circuit commutated turn-off time shall be quoted as a maximum value under specified conditions (*see* Appendix B for details).

7.12 Total Power Loss — Curves showing the maximum total power loss as a function of mean on-state current and conduction angle at a reverse voltage equal to the maximum value of the repetitive peak reverse voltage and at an off-state voltage equal to the maximum value of the peak off-state voltage shall be provided.

7.13 Critical Rate of Rise of Off-State Voltage — The critical rate of rise of off-state voltage shall be specified as a maximum value for at least one-third of the peak off-state voltage, and under specified gate conditions.

8. THERMAL CHARACTERISTICS

8.1 Thermal Resistance — The maximum value of thermal resistance from junction to reference point (according to method of cooling) shall be specified.

8.2 Transient Thermal Impedance — For thyristors intended to be used under cyclic overload conditions, the maximum value of transient thermal impedance also should be specified.

9. MECHANICAL DATA

9.1 Mechanical and other data required for the detailed mechanical design, assembly precautions, etc, should be applied as specified in **6.1** (f) and Appendix D of IS : 3700 (Part I)-1966*.

10. ENVIRONMENTAL AND RELIABILITY DATA — Under consideration.

11. CHARACTERISTIC CURVES

11.1 The following typical characteristic curves shall be given at the reference point temperature of 25°C and at one other higher reference point temperature chosen in **6.2**:

a) Mean off-state current *versus* maximum mean power dissipation for various conduction angles.

b) Mean off-state current *versus* maximum permissible reference point temperature for various conduction angles.

c) Gate triggering characteristics, namely, instantaneous gate voltage *versus* instantaneous gate current for triggering (*see* Fig. 2).

d) Surge current *versus* number of cycles.

e) On-state voltage *versus* on-state current at various temperatures.

f) Transient thermal impedance as a function of time.

g) Holding current *versus* reference point temperature.

*Essential ratings and characteristics of semiconductor devices: Part I General.

APPENDIX A

[*Clause* 6.4 (g)]

CRITICAL RATE OF RISE OF ON-STATE CURRENT

A-1. When a thyristor is switched to the on-state, conduction may occur initially in a localized small area of the device. The rate at which on-state current can be increased is limited by the rate of increase of this active area during turn-on. A rating for this rate-of-rise limitation $\left(\frac{di}{dt}\right)$ is needed in the design of power thyristor equipment.

A-2. The $\frac{di}{dt}$ rating is dependent on the following conditions which should also be specified:

a) Waveform and peak value of on-state current;

b) Switching repetition frequency;

c) Reference point temperature;

d) Forward off-state voltage prior to switching; and

e) Gate trigger conditions:

1) Value and waveshape of source voltage, and

2) Value of source impedance.

A-3. It is recommended that a damped sine-wave be used as the on-state current waveform as shown in Fig. 3. With this waveform, the recommended method of assigning a numerical value to $\frac{di}{dt}$ is as follows:

$$\frac{di}{dt} = \frac{I_{FM}}{2T_1}$$

where

$T_1 \geqslant 1$ microsecond, and

$I_{FM} \geqslant$ twice the mean on-state current rating.

NOTE — If the rated value of $\frac{di}{dt}$ is given, excluding an initial peak on-state current originating from discharge of an RC network connected in parallel with a thyristor, the permissible amplitude and duration of such an additional surge shall be stated.

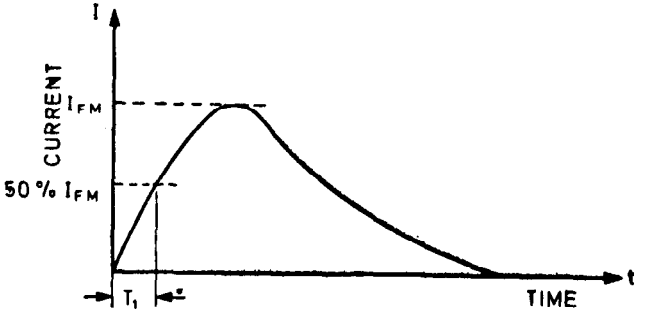


FIG. 3 ON-STATE CURRENT WAVEFORM FOR $\frac{di}{dt}$ RATING

APPENDIX B

(*Clause* 7.11)

CIRCUIT COMMUTED TURN-OFF TIME

B-1. The following is a list of conditions which should be specified while quoting the circuit commuted turn-off time:

a) The waveshape of the preceding on-state current.

NOTE — The waveshape should preferably be rectangular and the duration shall be sufficient to achieve charge carrier equilibrium. The amplitude shall be preferably three times the rated mean on-state current.

b) Rate of fall of on-state current $\frac{di}{dt}$.

c) Reference point temperature together with the duty cycle of the on-state current.

d) The waveshape of the reverse blocking voltage.

NOTE — The waveshape should preferably be triangular with an amplitude of at least two-thirds of the rated repetitive peak reverse voltage or rectangular with an amplitude equal to rated repetitive peak reverse voltage.

e) Reverse voltage at the time of initiation of off-state voltage (time instant T_1 in Fig. 4).

f) Peak value and rate of rise of off-state voltage.

NOTE — The peak value of the off-state voltage should be at least two-thirds of the rated peak off-state voltage.

g) Gate source voltage,

h) Gate bias while thyristor is in the off-state:
   1) Gate source voltage, and
   2) Gate source resistance.

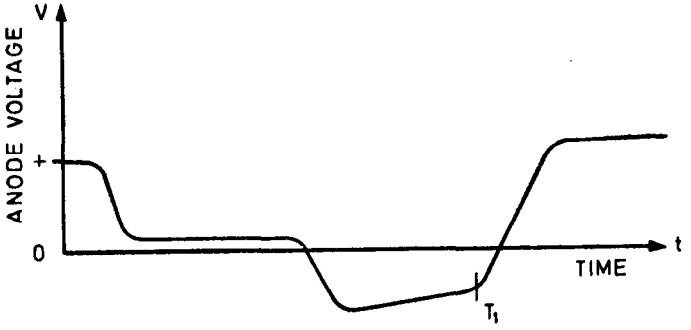


FIG. 4 ANODE VOLTAGE WAVEFORM DURING CIRCUIT COMMUTED TURN-OFF TIME MEASUREMENT

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002
Telephones: 331 01 31, 331 13 75 Telegrams: Manaksanstha
(Common to all Offices)

Regional Offices:	*Telephone*
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	331 01 31 331 13 75
*Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola, CALCUTTA 700054	36 24 99
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	2 18 43 3 16 41
Southern : C. I. T. Campus, MADRAS 600113	41 24 42 41 25 19 41 29 16
†Western : Manakalaya, E9 MIDC, Marol, Andheri (East), BOMBAY 400093	6 32 92 95

Branch Offices:

'Pushpak', Nurmohamed Shaikh Marg, Khanpur, AHMADABAD 380001	2 63 48 2 63 49
‡Peenya Industrial Area 1st Stage, Bangalore Tumkur Road BANGALORE 560058	38 49 55 38 49 56
Gangotri Complex, 5th Floor, Bhadbhada Road, T. T. Nagar, BHOPAL 462003	6 67 16
Plot No. 82/83, Lewis Road, BHUBANESHWAR 751002	5 36 27
53/5, Ward No. 29, R.G. Barua Road, 5th Byelane, GUWAHATI 781003	3 31 77
5-8-56C L. N. Gupta Marg (Nampally Station Road), HYDERABAD 500001	23 10 83
R14 Yudhister Marg, C Scheme, JAIPUR 302005	6 34 71 6 98 32
117/418 B Sarvodaya Nagar, KANPUR 208005	21 68 76 21 82 92
Patliputra Industrial Estate, PATNA 800013	6 23 05
T.C. No. 14/1421, University P.O., Palayam TRIVANDRUM 695035	6 21 04 6 21 17

Inspection Offices (With Sale Point):

Pushpanjali, First Floor, 205-A West High Court Road, Shankar Nagar Square, NAGPUR 440010	2 51 71
Institution of Engineers (India) Building, 1332 Shivaji Nagar, PUNE 411005	5 24 35

*Sales Office in Calcutta is at 5 Chowringhee Approach, P. O. Princep Street, Calcutta 700072 — 27 68 00

†Sales Office in Bombay is at Novelty Chambers, Grant Road, Bombay 400007 — 89 65 28

‡Sales Office in Bangalore is at Unity Building, Narasimharaja Square, Bangalore 560002 — 22 36 71

Reprography Unit, BIS, New Delhi, India